Feed the Future Tanzania Kilimo Tija Project

Technical Bulletin: Pest and Disease Identification and Management for Avocado

INTRODUCTION

In Tanzania, the cultivation of avocados is increasingly popular due to the high demand both locally and internationally. However, pests and disease pose a significant threat to productivity and crop quality. Integrated Pest Management (IPM) is a sustainable approach that combines biological, cultural, physical, and chemical methods to manage pests and diseases effectively. This bulletin provides guidance on identifying and managing key pests and diseases in avocado cultivation.

Figure 1: KTP beneficiary, Ms Zainabu Mahenge, an avocado producer at Mufindi DC.
Photo: Fintrac Global Inc.

INTEGRATED MANAGEMENT STRATEGIES

Effective pest management is crucial for maintaining avocado yield and quality while minimizing the negative impacts of insecticides. The golden rule is to avoid spraying insecticides until the specific pest has been identified and the population levels pose a threat of commercial damage that justifies interventions. If pest thresholds are exceeded, only chemicals registered for use on avocados against that specific pest should be considered, and their usage must comply with the accepted chemical and residue levels allowed in target markets.

Indiscriminate or random use of insecticides will disrupt the natural balance between pests and beneficial predatory insects in the orchards, leading to increasingly severe pest problems, costly control measures, and ultimately reduced profitability. Instead, an IPM approach is advocated, where "softer" chemicals may be used judiciously based on observations by trained scouts during critical times when predator populations are more susceptible.

The avocado crop in Tanzania is primarily affected by certain insects and arachnids that can reduce yields and quality. There are also a couple of quarantine pests that must be controlled to meet export

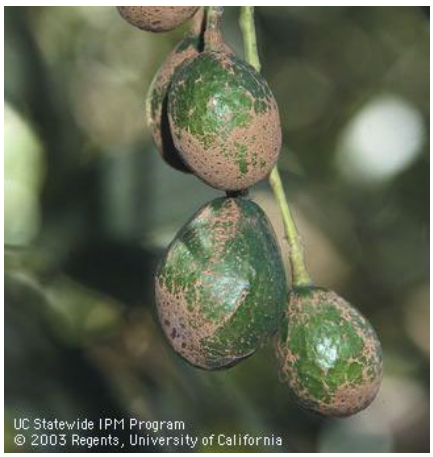
requirements for various markets. This section aims to identify and provide guidance on managing economically important pests in Tanzanian avocado production.

A. PESTS

I. THRIPS

Several general and species of thrips can affect avocado crops, but the most common are Heliothrips haemorrhoidalis, Selenothrips rubrocinctus, Scirtothrips aurantii, and Thrips tabaci.

- **Impact**: Both adult and larval stages of thrips cause damage through their feeding habits. They pierce and suck out the contents of plant cells, including chlorophyll, causing the cell walls to collapse. This results in discoloration (bronzing) on the surface of leaves and fruit. Heavy infestations can cause the pericarp (fruit skin) to crack. Feeding occurs during early fruit set and then later on more mature fruit. On mature fruit, the damage appears as irregular-shaped bronze patches, typically where the fruits touch each other, as thrips prefer to feed in these areas.



Figures 2 & 3: Photos showing damage by Heliothrips haemorrhoidalis.

- **Identification Tips:**
  - **Adult Thrips**: Adult thrips are tiny, slender insects, typically measuring 1 to 2 mm in length. They possess narrow fringed wings, which are often folded over their backs when not in flight. The body color can vary widely among species, ranging from yellow and brown to black. Adults can be distinguished by their unique asymmetrical mouthparts which are designed to pierce and suck plant cells. They are fast-moving and can jump when disturbed. Adult thrips are often found in flowers, on fruits, or under leaves, particularly attracted to white and light-colored surfaces.
  - **Larvae:** Thrips larvae resemble the adults but are smaller, wingless, and usually lighter in color, often yellow or pale green. Thrips undergo two larval stages. The first stage larvae are tiny and freshly hatched, while the second stage larvae are slightly larger and more active. Larvae are typically found feeding on the same plant tissues as adults, such as leaves, stems, and flowers, where they can cause significant damage.
  - **Eggs**: Thrips eggs are microscopic, elongated, and kidney-shaped. They are often translucent or white, making them very difficult to see with the naked eye. Eggs are usually inserted into plant tissue, particularly within leaves, stems, or even inside flower parts. This placement protects them from external conditions and predators. Locating thrips eggs often requires a magnifying glass or a microscope. The presence of adults and larvae on a plant can be a cue to inspect for eggs in nearby tissues.

Figure 4: Adult Heliothrips haemorrhoidalis

Figure 5: Nymphs and black excrement of greenhouse thrips, Heliothrips

- **Management Strategies**: While thrips are generally considered a minor pest in avocado orchards, it has the potential to become a major problem if control methods are not carefully executed. It is crucial to remember that many thrips' species play important roles in pollination and as predators of other pests. The critical time for thrips control is during fruiting and early fruit development stages. To determine the need for control measures, weekly scouting is essential.

- **Control Options**
  - **Cultural**:
    - **Pruning and Hygiene:** Regularly prune dense foliage to improve air circulation, which helps reduce the humidity levels that thrips favor. Remove and destroy heavily infested plant parts to reduce thrip populations.
    - **Water Sprays:** Regularly washing down plants with a strong jet of water can physically remove thrips from the leaves and disrupt their life cycle.
  - **Biological**:
    - **Predatory Mites:** Introduce or encourage populations of natural enemies such as foliar predatory mites (e.g., Phytoseiulus persimilis) which are effective at controlling pest thrips populations.
    - **Traps:** Blue and yellow traps can be used to control thrips, with the aim of capturing adult thrips to minimize reproduction.
    - **Other Natural Predators:** Lacewings and ladybugs also prey on thrips and can be part of a biological control strategy.
  - **Chemical**:
    - **Selective Insecticides:** Use insecticides that target thrips specifically if populations exceed economic thresholds. Products like Imidacloprid, Thiamethoxam, and Spinosad can be sprayed if required.
    - **Application Timing:** The crucial time for thrips control is during fruiting and early fruit development. To determine control, it is important to scout every week.
  - **Integrated Approaches**
    - **Row Covers:** Use row covers for young plants to physically block thrips from reaching the plants.
    - **Crop Rotation:** Rotate crops with non-hosts to break the lifecycle of thrips.

II. MITES

Mites, sometimes referred to as spider mites or red spiders, are not insects but are more closely related to spiders. Adult mites have eight legs, unlike the six legs found in insects, and are very small in size. They feed by piercing and sucking plant sap and chlorophyll from plant tissues using their mouthparts. Despite their minute size, mites can cause significant damage due to their ability to reproduce rapidly and, in some species, inject toxic substances into the plant tissue. The most prevalent mites affecting avocados include the avocado brown mite (*Oligonychus punicae*) and the persea mite (*Oligonychus perseae*).

- **Impact**: Mites primarily infest the upper surface of leaves, initially along the midrib and later spreading to the veins and eventually covering the entire upper leaf surface. Their presence is evidenced by brownish discoloration, which can eventually cover the entire upper leaf surface. Infestations are also characterized by myriads of whitish hatched eggs and cast skins of the mites. Defoliation occurs only when mite populations are extremely high, and control measures are typically not employed unless the infestation is exceptionally severe.
- **Identification Tips:** Mites are extremely small and often require a hand lens to see. They appear as tiny red, brown, or yellow dots moving on the leaf surface, especially under leaves. Webbing and a dusty appearance on leaves can also signal mite presence.
  - **Adult Mites:** Adult mites are extremely small, typically less than 1 millimetre in size, making them difficult to see without magnification. They come in various colors, including red, yellow, green, or brown, depending on the species. Mites have eight legs, unlike insects, which have six. Their bodies are often oval and somewhat flattened. Some species may have two distinct body segments, while others appear more rounded.

Figure 6 (Left): Avocado brown mite damage causes bronzing on the upper leaf surface.
Figure 7 (Right): Persea mite damage forms distinct circular, yellow or brown spots along veins on the leaf underside. Spots become visible through the upper leaf surface.

  - **Larvae:** Mite larvae are smaller to adults but have only six legs. They are usually pale and translucent, making them even more difficult to spot than the adults. After hatching from eggs, larvae undergo several developmental stages, including one larval stage and one or more nymphal stages, before becoming adults. Each stage involves a period of feeding followed by molting.
  - **Eggs:** Mite eggs are spherical and extremely tiny, often translucent or slightly opaque. Some species lay colored eggs that can be red, orange, or yellow. Eggs are commonly deposited on the undersides of leaves, often near leaf veins or in protected areas along stems and crevices.
- **Management Strategies**: As mites are generalist pests, most species can be controlled using similar methods. Weekly scouting is crucial for making informed spraying decisions.
- **Control Options:**
  - **Cultural**:
    - **Pruning and Hygiene:** Regularly prune dense foliage to improve air circulation, which helps reduce the humidity levels that mites favor. Remove and destroy heavily infested plant parts to reduce mite populations.
    - **Water Sprays:** Regularly washing down plants with a strong jet of water can physically remove mites from the leaves and disrupt their life cycle.
  - **Biological**:
    - **Predatory Mites:** Introduce or encourage populations of natural enemies such as predatory mites (e.g., Phytoseiulus persimilis) which are effective at controlling pest mite populations.
    - **Other Natural Predators:** Lacewings and ladybugs also prey on mites and can be part of a biological control strategy.
  - **Chemical**:
    - **Miticides:** Natural predators of mites are often sufficient, however, if mite populations reach critical levels, targeted miticides such as Abamectin, or a good Sulfur fungicide can be used.

Figure 8 (Left): Adult avocado brown mites are dark to brown and lay amber to brown eggs.
Figure 9 (Right) The Persea mite is yellow to green with two or more dark blotches on its body.

III. FRUIT FLIES

Fruit flies are quarantine pests, with several species known to attack different commercially grown crops. In avocados, the economically important genera are Ceratitis and Bactrocera, causing considerable damage.

- **Impact**: The female punctures the fruit with her ovipositor and deposits eggs within the host fruit. Larval development inside the fruit causes direct damage and may lead to rot. Larvae then drop to the soil to pupate. Losses occur from direct feeding damage and due to loss of export markets as a result of quarantine restrictions imposed by importing countries free of these pests.
- **Identification Tips:** Proper fruit fly monitoring is crucial for timely detection of infestations. This is typically achieved using monitoring traps or stations:
    - For Ceratitis, traps with Trimmed lure catch males of C. capitata. Traps with enriched ginger oil catch several species (mostly males). Traps with Quest lure catch C. capitata, C. cosyra, C. rosa (males and females), and Biolure-fruit-fly traps catch all three species (males and females).
    - For Bactrocera invadens, monitoring and control can be done with a highly species-specific lure, Methyl Eugenol (ME), which attracts males only.
    - **Adult Fruit Flies:** Adult fruit flies are about the size of a housefly, usually 4-7 mm long, and can be distinguished by their bright colors and distinctive patterns. They typically have a banded appearance with yellow and black stripes across the abdomen. Fruit flies are highly active, especially in warm weather. They are often seen hovering around ripening or damaged fruits.
    - **Larvae:** The larvae are small, white, and legless, typically found inside the fruit. They can grow up to 10 mm in length as they mature. Presence of larvae is usually noticed only after the fruit has been cut open, revealing the maggots inside the flesh.
    - **Eggs:** Eggs are tiny, elongated, and white, usually laid in groups inside the flesh of ripening fruits. Eggs are typically inserted into the fruit through small punctures made by the female fly.

Figure 10 (Left): Bactrocera invadens fruit fly
Figure 11 (Right): Bactrocera dorsalis fruit fly

Photo: Centre for Invasion Biology

- **Management Strategies**: Avocados are not a good host for fruit fly development, and under good orchard practices, larval development in fruit on the tree is uncommon. If it occurs, there is usually a main host plant nearby (e.g., mango, papaya, or watermelon). Ripe fallen fruit on the ground can lead to higher fruit fly presence in the orchard. Therefore, it is advisable to clear the orchard floor of any fallen fruit to prevent fruit flies from breeding in the orchard.
- **Control Options:**
  - **Cultural**:
    - **Sanitation**: Remove and destroy infested and fallen fruits from the orchard promptly to reduce breeding sites and interrupt the fruit fly lifecycle.
    - **Bagging Fruits:** Physically protect fruits by bagging them on the tree with paper or mesh bags to prevent females from laying eggs in the fruits.
  - **Biological**:
    - **Parasitoids**: Release parasitic wasps that target fruit fly larvae or eggs. These natural enemies can help control fruit fly populations without the need for chemical interventions.
    - **Entomopathogenic Fungi**: Use fungal pathogens that specifically target fruit flies, applying them to areas where flies are prevalent.
  - **Chemical**:
    - **Targeted Insecticides:** If necessary, apply insecticides that are specifically labeled for fruit fly control. Use them judiciously, focusing on critical times such as pre-harvest intervals to minimize impact on the fruit quality.
    - **Bait Sprays:** Instead of broad-spectrum spraying, use bait sprays that combine attractants with insecticides. This method targets fruit flies more effectively and reduces the amount of chemical used.

IV. FALSE CODLING MOTH (FCM) (Cryptophlebia leucotreta / Thaumatotibia leucotreta)

FCM adults live for two to three weeks, during which time the female mates several times. The eggs are laid (oviposited) on the fruit. Cannibalism among the larvae ensures that most often only one larva develops on a fruit. Larvae may gnaw through the skin but are unable to develop further (for C. leucotreta). Entrance holes on the fruit can be spotted by the white exudate and frass (insect waste), which is often apparent. The larva exits the fruit upon pupation, dropping to the ground and pupating in a cocoon of fine soil particles on the soil surface or beneath leaf litter.

- **Impact**: Larvae entry into fruits leads to internal decay, making the fruit inedible and unsuitable for market. Entry holes can also be an entry point for secondary infections like bacteria and fungi. Apart from entry holes and frass, infested fruits may show signs of premature ripening or yellowing near the infestation site.
- **Identification Tips:**
  - **Adult Moth:** The adult moth has a wingspan of about 15-20 mm. The forewings are generally greyish brown with a slight pinkish or reddish hue and have distinctive dark brown markings towards the tips. The hind wings are lighter, usually whitish, or grey, with a darker fringe. Adults are primarily nocturnal and are attracted to light, which can be used as a method to monitor their activity and numbers through light traps.
  - **Larvae:** The larvae are caterpillar-like, with a creamy white to pink body and a distinct dark head. They can grow up to 15 mm in length. Larvae bore into fruit to feed, usually entering near the stem or along the side. Entry points are marked by tiny holes surrounded by frass (excrement) that looks like fine sawdust. Inside, the larvae make irregular tunnels filled with more frass.
  - **Eggs:** Eggs are tiny, oval, and flat, with a creamy to yellowish color. They are often laid singly or in small clusters on the surfaces of leaves or fruits. They are typically found on the upper surfaces of younger, softer leaves or near potential entry points on fruit.

Figure 12: An adult false codling moth *Photo: Greenlife Crop Protection Africa*

- **Management Strategies**: Orchard sanitation measures have remained the single most important recommendation for suppressing the FCM pest in avocado orchards. There are also some specific control methods that can be implemented, like mating disruptants. This method relies on preventing mating and reducing the deposition of viable eggs on the fruit. This is achieved by releasing high concentrations of female sex pheromones, which confuses males

and prevents them from finding females to mate. This should be applied early in the season when the FCM population is still low.

Some avocado-approved agrochemicals can also be applied. Bait traps containing pheromones (e.g., "Last Call") and poisons are placed in the orchards to attract and control the moths. Broad-based insecticide sprays are only advocated in instances where baiting alone is not adequately controlling population levels and fruit damage is at significant levels.

Due to the complexity of its life cycle, more than one control measure should be used to control this pest. The FCM life cycle is relatively synchronized early in the season; therefore, a well-timed spray can provide significant benefit. Due to overlapping generations later in the season, linked to the ephemeral nature of some products, spraying late in the season may not be as effective. Spray coverage is very important, as the insides of the trees should be adequately covered with active pesticides to manage neonate larvae.

- **Differences between fruit fly and FCM damage:** Lesions caused by fruit flies and FCM (C. leucotreta) are often confused. During the first few weeks of fruit damage, the fruit fly and FCM lesions are very similar, both displaying a small hole covered by dried fruit sap, which later becomes a white powder. However, fruit damage by the fruit fly's ovipositor develops into a typical star-shaped lesion, in contrast with FCM, which raises a crater with an inconspicuous hole in the middle where the FCM larva has entered. Granular excreta can also be seen in the case of FCM.

V. APHIDS

Aphids are soft-bodied insects that feed on plant sap using their piercing-sucking mouthparts. They typically occur in colonies on the undersides of tender, terminal growth. Aphids may become abundant on avocado trees growing in close proximity to aphid-infested citrus trees. The species involved are those ordinarily found on citrus, mainly the spirea aphid (Aphis spiraecola) and the melon aphid (Aphis gossypii).

- **Impact**: Aphids feed by sucking sap from plants, which can lead to yellowed, distorted, and stunted leaves. Heavy infestations can weaken the plant significantly. In addition to physical damage to the plant, aphids secrete a sticky substance known as honeydew, which can attract ants and promote the growth of sooty mold fungus on the leaves and fruits.
- **Identification Tips**:
  - **Adult Aphids and Nymphs**: Aphids are small, soft-bodied insects, typically measuring 1 to 10 mm in length. They can be green, yellow, brown, red, or black depending on the species and the plants they infest. Most aphids have pear-shaped bodies with long legs and antennae. Aphids are often found in clusters, especially on new growth and the undersides of young leaves. They can reproduce rapidly, especially in warm weather, leading to large infestations in a short time.
  - **Larvae**: Aphid larvae look similar to adults but are smaller. They are born live and can start feeding on plant sap immediately. Presence of larvae along with adults can indicate a rapidly growing aphid population.
  - **Eggs**: Aphid eggs are tiny, oval, and usually a matte black or dark green color. They are often laid in protected areas on the plant, such as in crevices or near buds. Eggs are typically laid in the fall and hatch in the spring in climates with cold winters. In tropical or mild winter regions, many species of aphids may continue to reproduce without laying eggs.

Figure 13: Aphis spiraecola (green) and Aphis fabae (black)
Photo: www.influentialpoints.com

- **Management Strategies**: Aphids have many natural predators, and low populations generally do not pose a significant threat to avocado farmers. They usually affect crops during the dry season, and due to their soft-bodied nature, low infestations can be controlled with natural products like agricultural oil, soap, garlic, and neem extracts. If damage reaches economic levels that justify the use of agrochemicals, products like imidacloprid and thiamethoxam can be sprayed.
- **Control Options:**
  - **Cultural**
    - **Pruning**: Remove and destroy heavily infested plant parts to reduce aphid populations and prevent spread.
    - **Water Sprays**: Dislodge aphids from plants using a strong jet of water; this can be an effective method for managing light infestations.
  - **Biological**
    - **Natural Predators**: Ladybugs, lacewings, and parasitic wasps are natural predators of aphids and can be introduced or encouraged to naturally control aphid populations.
    - **Botanical Insecticides**: Neem oil and other botanical insecticides can deter aphids without harming beneficial insects when used correctly.
  - **Chemical**
    - **Insecticidal Soaps**: These can be effective against aphids without causing much harm to beneficial insects. Apply early in the infestation and ensure thorough coverage, especially on the undersides of leaves.

VI. SCALES

There are different types of scales that affect avocados, the most common being the heart-shaped scale (Protopulvinaria pyriformis). Scales feed mainly on the underside of avocado leaves, extracting plant sap. Fruit and shoots can also be attacked. Scales excrete honeydew, which settles on the lower leaves and fruit. Female scales reproduce parthenogenetically (without males) and lay about 200-300 eggs, protected by a white, woolly secretion beneath her body.

- **Impact**: Scale insects suck sap from plants, which can lead to yellowing leaves, stunted growth, and branch dieback. Scales excrete a sticky substance known as honeydew, like aphids, which leads to sooty mold growth on leaves and fruit. Additionally, infested areas may appear as bumpy or scaly patches. Heavy infestations can weaken the plant significantly.
- **Identification Tips**:
  - **Adult Scales**: Adult scale insects are small and typically range from 1 to 3 mm in size. They are covered by a waxy, protective shell that can be circular, oval, or oblong and varies in color from brown or gray to white, depending on the species. Scales are generally immobile once they are mature and have attached themselves to a plant. They can be found on stems, the undersides of leaves, and sometimes on fruit.
  - **Nymphs**: Nymphs, often called "crawlers," are tiny, mobile, and lack the protective covering of the adults. They are usually yellow to orange in color and move around the plant until they find a suitable spot to feed and develop. Crawlers are the stage most likely to spread to new plants as they can be carried by wind or inadvertently by animals and humans.
  - **Eggs**: Eggs are often laid under the protective shell of the female scale and can be white, yellow, or orange. They are extremely small and can be numerous. Typically found beneath the female scale's body, eggs remain protected until they hatch into mobile crawlers.
- **Management Strategies**: Scale insects are among the more insidious pests affecting avocado trees, capable of causing significant damage if not controlled. These pests attach themselves to the leaves, stems, and fruits of trees, sucking sap and weakening the plant. Effective management of scale insects is crucial for maintaining the health and productivity of avocado orchards.
- **Control Options:**
  - **Cultural**
    - **Pruning**: Remove and destroy parts of plants heavily infested with scales to prevent them from spreading.
    - **Sanitation**: Keep the area around plants clean and free of plant debris to reduce hiding spots for scales.
  - **Biological**
    - **Natural Predators**: Encourage or introduce natural enemies such as ladybugs, lacewing larvae, and parasitic wasps that specifically target scale insects.
    - **Botanical Insecticides**: Apply horticultural oil during the dormant season or early in the growing season to smother eggs and crawlers. Biological products like Beauveria and Metarhizium have also demonstrated good control against scales.
  - **Chemical**
    - **Targeted Insecticides**: Use insecticides that are effective against scales, such as systemic insecticides, which are absorbed by the plant and can control scales without extensive spraying. Always follow the recommended application rates and timing for maximum effectiveness.

Figure 14: Protopulvinaria pyriformis, or "heart-shaped scale."
Photo: John .A. Davidson, Univ. Md, College Pk, Bugwood.org

B. DISEASES

Like pests, diseases in avocado orchards can lead to significant losses in both yield and quality of fruit. While the avocado is considered a hardy crop, it is susceptible to various phytosanitary problems that farmers must address. Growers need to be well-versed in strategies for identifying, preventing, and controlling the pathogens that cause diseases in their avocado plantations. Effective disease management is essential to keep yield losses at economically acceptable levels and prevent the introduction of new disease threats.

1. ROOT ROT (caused by Phytophthora cinnamomi)

Phytophthora root rot is considered the most destructive and significant disease affecting avocado crops. It can be extremely serious, capable of killing most trees in an orchard. Nursery plants and young replanted trees are particularly susceptible to root rot and often succumb shortly after infection.

Figure 15 (Left): Avocado roots darkened and killed by Phytophthora root rot.
Figure 16 (Right): Old drooping leaves with necrotic tips on an avocado with Phytophthora root rot.

- **Symptoms:** Phytophthora species can invade the roots and crowns of woody trees, but foliar symptoms may not become evident for several months or even years. Infected trees exhibit pale green, wilted leaves that readily fall off. Shoot dieback occurs from the tips, eventually reducing the tree to a bare framework of dying branches. Declining trees commonly set large crops of small avocado fruit. The lack of foliage and dieback of small branches exposes the fruit and major limbs to sunburn. Feeder roots appear black, decayed, and sparse. As infected roots lose their ability to exclude salts, leaf margins develop brown, necrotic symptoms typical of salt burn. Under severe waterlogging conditions, rapid tree decline may occur, with leaves wilting and dying, leaving a canopy of brown, dead foliage. A weeping stem canker may also develop on the lower trunk. The soil environment plays a crucial role in symptom development when Phytophthora is present. Symptoms only appear when there is an imbalance between the water requirements of the leaves and the capacity of the roots to absorb water.
- **Control Options:** An integrated approach that combines pathogen-free nursery trees, cultural and biological controls, resistant rootstocks, and chemical treatments, is recommended for effective management of Phytophthora root rot.
    - **Cultural:**
        - Plant on well-drained soils or improve drainage by using mounds.
        - Irrigate carefully, avoiding both over- and under-irrigation.
        - Increase soil organic matter content using ground covers and mulch, but keep mulch away from tree trunks.
        - Apply lime (or gypsum if pH is optimal) under the tree canopy to suppress spore formation. High soil pH favors disease development.
        - Provide adequate nutrition.
    - **Chemical:**
        - Use recommended systemic chemical fungicides in addition to cultural practices.
        - For young trees, follow good nursery practices and use Aliette (Fosetyl Aluminum) stem paint. At planting, a soil treatment with Metalaxyl may also be used to suppress the fungus, but resistance can develop after the first year.
        - For older trees, options include foliar sprays with commercially registered Fosetyl Al formulations or annual/biannual trunk injections with registered products like "Avoguard."
        - Timing of trunk injections is crucial to ensure good efficacy and compliance with maximum residue tolerances in target markets. Seek expert advice before proceeding with injections.
    - **Biological:**
        - Preventatively inoculate with beneficial microorganisms like Trichoderma, Bacillus subtilis, and other effective microbes to suppress the pathogen in the soil.
- **Integrated Management:** Phytophthora root rot cannot be controlled by a single method. An integrated approach combining cultural practices (proper land preparation, drainage, good nursery practices, irrigation management, timely weeding), biological inoculations, and judicious use of agrochemicals is necessary for effective management.

II. ANTHRACNOSE (Colletotrichum spp.)

For the Hass avocado variety, a warm and humid subtropical microclimate can be highly conducive to fungal proliferation. The most prominent post-harvest disease to be expected is anthracnose, caused by the Colletotrichum fungus, which manifests as rotting in ripening fruit.

Figures 17-20: Avocado plants showing Anthracnose infection at different fruit stages.
Photo: Queensland Government, Department of Agriculture and Fisheries

- **Symptoms:** These fungal diseases cause the development of dark, sunken spots or lesions, often with a raised rim, on affected foliage, stems, and fruit across a wide range of horticultural crops. Initially, pink spores are observed, followed by the formation of black fruiting bodies. Immature fruit do not show infections until they ripen. Disease development after harvest is the result of fruit infection on the trees before harvest, with the fungus remaining dormant in green fruit for several months. Leaf spots are large and tan-colored with dark brown margins. Pinkish spore masses may form on the spots under humid conditions, but leaf spots are extremely rare and generally form only after prolonged wet or humid weather. Large circular brown spots may develop around puncture marks on the fruit's skin. These spots darken with age, and their centers become sunken. In moist conditions, pinkish spore masses may form on the spots. Small spots less than 5 mm in diameter may develop around the breathing pores (lenticels). The fungus also causes a major post-harvest problem in ripe fruit, with the rotting penetrating deep into the flesh in a hemispherical pattern. Pepper spots, appearing as a myriad of small, dark, raised spots on the fruit's surface, are also observed. The fungus affects twigs as well.
- **Control Options:** The critical phases for disease control are during flowering, fruit set, and after harvest. This disease is most severe during wet weather, when new growth flushes are particularly susceptible. While the leaf spot symptom is generally not serious enough to warrant treatment or preventative measures, prevention against fruit rot requires regular spraying and orchard hygiene.
    - **Cultural:**
        - Prune to promote good air circulation, reducing leaf wetness and humidity around the fruit and foliage.
        - Remove and destroy infected plant debris to reduce the source of inoculum.
    - **Chemical:**
        - Follow a recommended fungicide spray program for the crop from flowering to fruit set. Control fruit-damaging pests such as false codling moth and fruit flies.
        - Use copper-based fungicides and other registered fungicides during periods of high humidity and after rainfall.
    - **Biological:**
        - Use regular leaf and soil analyses to maintain adequate nutrient levels, particularly calcium and nitrogen, as this increases the fruit's resistance to infection.

III. LEAF SPOT (Cercospora sp.)

Leaf spot diseases are a collective term for various fungal and bacterial infections that cause discolored lesions or spots on the leaves of affected plants.

Figure 21: Leaf spot, also know as avocado black spot, caused by Cercospora
Photo: www.agro.basf

- **Symptoms:** Small, brown flecks with a reddish border develop initially, expanding to circular spots about 4 mm wide with an ashy-grey center. This affected tissue becomes thin, brittle, and often drops out, leaving a ragged hole. Round, water-soaked lesions develop on leaves, petioles, and stems. The lesions enlarge and have light brown centers with dark brown-red margins. As the lesions expand, an outer water-soaked area and dark ring may form beyond the original lesion margin, resulting in the lesion center becoming surrounded by concentric rings. With age, the lesion centers dry out and crack. In avocados, dark brown lesions develop on leaves and fruit.
- **Control Options:** The goal should be to prevent fungal diseases like Cercospora leaf spot from occurring in the first place. Before considering treatment, focus on prevention.
    - **Cultural:**
        - Cercospora is often transmitted from plant debris or weeds around the tree, so ensure you clean up all fallen leaves, shed fruit, and remove any unwanted plants in the area. Remove any avocados that were not picked or fell last year.
        - Proper airflow is crucial. Fungal infections thrive in pockets of stagnant air that allow humidity to build up, creating favorable conditions. Thinning the inside branches of your avocado trees, like with any fruit-bearing tree, will not only decrease humidity in the canopy but also improve fruit quality.
    - **Chemical:**
        - Copper spray, applied three to four times a year, seems to keep the Cercospora fungus under control.

CONCLUSION

Effective management of pests and diseases is crucial for sustaining the productivity and profitability of avocado orchards. This bulletin has provided detailed identification tips and integrated management strategies for common threats such as thrips, mites, and other pests and diseases. By understanding the specific characteristics and behaviors of each pest and disease at every stage of their life cycle, growers can implement more targeted and effective control measures.

Monitoring is a key component of successful IPM. Regular and thorough inspections, combined with the use of sticky traps and other monitoring tools, allow for the early detection of infestations and infections. Early intervention is critical to prevent significant damage and to manage populations at an acceptable level.

Cultural practices such as proper irrigation management, pruning, and sanitation reduce the likelihood of severe pest and disease outbreaks and are essential elements of a sustainable management strategy. Biological controls, including the introduction of natural predators and the use of biopesticides, provide environmentally friendly options that help maintain the ecological balance within the orchard.

When chemical controls are necessary, they should be used judiciously, with careful consideration for their impact on non-target organisms and the environment. The strategic use of chemicals, guided by the principles of IPM, ensures that interventions are both effective and sustainable.